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February 10 and 11, 1998
Maritimes Regional Advisory Process (RAP)

The Gully Science Review

P.D. Keizer (Chairperson and Editor)

Marine Environmental Sciences Division
Science Branch
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ABSTRACT

Meeting 7 of the Habitat Subcommittee of the Maritimes Regional Advisory Process (RAP) was held on February 10 and 11, 1998 to assess The Gully Science Review. This Research Document and the draft Habitat Status Report had been assembled by a review team drawn from local expertise, including government, university, and NGO (non-governmental organization) members. The RAP meeting was attended by most of the contributors to the Review, a number of other scientists and members of NGOs and three, invited, external reviewers. The meeting identified a number of information gaps that are important to understanding the importance of the Gully area to offshore ecosystems and prepared a number of recommendations regarding research, surveys, and approaches to studying and understanding offshore ecosystems.

RÉSUMÉ

La septième réunion du Sous-comité de l'habitat du Processus consultatif régional (PCR) des Maritimes a eu lieu les 10 et 11 février 1998. Elle avait pour but d'évaluer l'étude scientifique du Gully. Le document de recherche et l'ébauche de rapport sur l'état de l'habitat présentés ici ont été établis par une équipe d'évaluation composée de spécialistes locaux, notamment de représentants gouvernementaux, d'universitaires et de membres d'organisations non gouvernementales (ONG). La plupart des personnes qui ont participé à l'étude scientifique ont participé au PCR, en compagnie de divers autres scientifiques et membres d'ONG ainsi que de trois évaluateurs externes invités. La réunion a permis de cerner certaines lacunes dans l'information nécessaire pour comprendre l'importance du Gully dans les écosystèmes du large, et de formuler diverses recommandations concernant la recherche, les relevés et les approches possibles à l'étude et à la compréhension des écosystèmes du large.

OBJECTIVE OF THE MEETING

During the summer of 1997, various groups expressed interest in an area on the Scotian Shelf off Nova Scotia termed the Gully. This underwater canyon just east of Sable Island has commercial fish resources, as well as non-commercial species such as whales and seabirds. The geographical uniqueness of this large canyon, and the suspected biological significance of the area has attracted the interest of government agencies, researchers, and conservationists. A number of concerns have been raised about development in the area and there have been calls for special protection measures. However, there has not been a systematic study of the Gully to determine whether or not it has special features that require protection. Therefore, a team of scientists was struck to:

- **Identify the special features of the Gully within the broader context of the Scotian Shelf ecosystem.**

This team conducted a series of meetings, often involving stakeholders, during the summer and fall of 1997 and has produced a research document describing the environment and ecosystem(s) of the Gully and surrounding area, including:

- Geoscience and hydrography
- Physics and chemistry
- Biological oceanography
- The benthic community
- The finfish community
- Marine mammals
- Seabirds
- Ecosystem classification

Purpose of the RAP Review

The purpose of the RAP meeting is to review the findings of the Gully team and to produce a Habitat Status Report (HSR) summarizing the conclusions of the RAP. The final HSR will be based on the draft presented by the Gully team.

The RAP will attempt to answer the following questions:

1. Was the information that the team had available to them analysed in the most appropriate manner to answer the issue posed to the team?

2. Are the conclusions as presented in the draft Habitat Status Report valid given the analyses that were presented?

3. What other analyses are appropriate to addressing this issue?

4. What further research is required on this issue?

BACKGROUND

Paul Keizer tabled the agenda and presented a brief background of the events leading up to this review as documented in Section 1.0 of the Review. (Note: Throughout this document the "Review" refers to RAP Working Paper 98/36, entitled "The Gully Science Review", editors Glen Harrison and Derek Fenton).

Glen Harrison then presented the draft Habitat Status Report (HSR). There was a discussion of the HSR with reference to the meaning of "unique/special features". Peter Auster noted that in order to provide recommendations to management regarding potential protective measures, the review should not only identify special features but also representative features. Kees Zwanenburg noted that the objective of his review was not to find special features but to identify and interpret the information that was available about the Gully. There was agreement by other reviewers that this was the case. Glen Harrison noted that the fundamental question that we are trying to address is "what do we know about the Gully ecosystem?" and in the process of addressing that question we will also address the more specific question that was originally charged to the scientific team.

PRESENTATIONS

Presentations were made for each of the chapters in the Review with the exception of Chapters 5 and 10. It had been agreed with the authors of Chapter 10 that this information was more appropriately presented at the roundtable on marine protected areas held later in the week. Dr. Chapman, the local acoustics expert from the Defense Research Establishment Atlantic, was not able to participate in the RAP meeting consequently the acoustics chapter of the review was not discussed. Rapporteurs were assigned for each presentation and, on the second day of the meeting, reported on the issues raised during the discussion. For clarity and organization their reports and the subsequent discussion follow the summary of each presentation.

This document is a record of the discussions that occurred during and following the presentations and the rapporteurs' reports. It is not a record of the presentations. Readers are advised to read the Review for the details of the information that was presented. Recommendations arising from the discussions at the meeting are recorded in Section 6 of this document.

Geosciences and Hydrography

Presentation and Discussion- Gordon Fader

Gordon Fader summarized the material contained in Chapter 3, Surficial, Bedrock Geology, and Morphology of the Gully, and Chapter 4, Hydrography of the Gully, of the Review.

Mr. Fader noted that the Gully is extremely steep with slopes on the order of 50 degrees and that it is unique with respect to other canyons on Canada's eastern continental shelf

in that it cuts deeply into the Shelf. The steep walls of the Gully are characterized by outcropping bedrock consisting of semi-indurated mud stone and silt stone. However, much of the geological information about the Scotian Shelf was collected before the development of many of the techniques we presently use to study the ocean bottom. Therefore we know less about the geology of the Gully than more recently studied areas, such as the Grand Banks.

Dr. Carl Amos has conducted a number of studies on the Scotian Shelf and has concluded that the major pathway for sediment transport along the Shelf is from west to east. Dr. Amos also hypothesized the presence of a "hydraulic fence" that prevents sand from moving off of the Banks. Mr. Fader presented a multibeam bathymetric image of 4 small canyons at the western edge of the Gully that had recently been collected by Dr. Amos. These data suggest that there may be movement of sediment off Sable Island Bank into the Gully through these canyons. There is insufficient information available to determine whether or not the hydraulic fence concept applies to these small canyons. It was also noted that Carl Amos has data on substrate type and benthos from submersible studies undertaken in the late 1980s.

It was noted that there is a zone of sediment disturbance associated with earthquake activity north of the Gully and Banquereau along the Glooscap Fault.

Dr. Trevor Kenchington and Peter Auster noted the statement in chapter 3.0, Section 3.0.7, p. 9 "Hydraulic clam harvesting takes place on Banquereau, directly northeast of the Gully. This activity liquefies fine-grained sand, putting it into suspension, and making it more readily available under storm conditions for transport off the bank and into the Gully." Don Gordon noted that there is very little of this activity on Banquereau and that it was unlikely to be a significant factor.

Rapporteur's Report and Discussion - Derek Fenton

The slope of the Gully, its surficial geology and the grain size of the sediments effect the nature of benthic communities and the biodiversity. There are enough bathymetric and geological data to describe the unique physical features of the inner Gully with respect to the extreme slopes and its impact on the mean circulation. However, more information is required to characterize the surficial geology particularly in the deeper parts (> 200 m.) where we have information on <1% of the area. Similarly the bathymetric data were collected for navigational purposes and have limited resolution. More detailed knowledge of the bathymetry is required to assess the zonation of benthic communities .

The information from Carl Amos' recent work indicates that there may be active sediment transport into the Gully via the 4 small canyons on the west side. It was suggested that the "hydraulic fence" concept may not apply to the area of the 4 small canyons but may still be valid for other areas of the banks.

Information Gaps:

- The geology of the Gully is based on older data-sets and consequently less well known than adjacent regions (e.g. Grand Banks) where newer data gathering techniques have been used.
- There is little information on the geology of the deeper (>800m) areas of the Gully; <1% of that area has been surveyed.

Physical Oceanography

Presentation and Discussion- Dr. Brian Petrie

Dr. Brian Petrie summarized the modeled circulation of the Gully area and its influence on the immediate area of the eastern Scotian Shelf and Slope area. He noted that the model is based on temperature and salinity data and that the Gully does not have an extensive data set. Interannual variability of temperature and salinity, current variability and currents associated with the surface tides behave in the Gully like other areas of the Scotian Shelf.

It was also noted that the model predicts a counterclockwise gyre in the surface waters and a weaker, clockwise gyre in the deeper water. Dr. Petrie cautioned about taking the model predictions too far since it is being applied near its limits and there is no verification at the scales appropriate to these types of features. The clockwise gyre predicted by the model at depth is very weak and may not exist.

The high energy internal waves in the Gully as reported by Sandstrom and Elliott (1984) do not appear to affect the density structure in this region any more than the surrounding areas.

Rapporteur's Report and Discussion - Dr. Phil Yeats

Dr. Yeats noted that events that happen on a short time scale can be more important than the average, persistent features. In order to understand the importance of these short time scale events, there is a need to apply new technologies for data collection. It was noted that regular, not extreme, storm events have been observed to generate currents in the order of meters per sec. in other areas of the shelf break. These currents can move material very large distances in a short period of time.

The current model prediction of a residual flow from the Gully to the northwest may have important implications for biological processes. With respect to potential impacts of the Sable Offshore Energy Project (SOEP), the nature of the gyre in the Gully and to what extent the physics contributes to productivity and to the concentration of food could be important processes.

It is possible to predict where internal waves will be generated based on bottom slope and local water stratification. We do not have oceanographic data from the deeper parts of

the Gully comparable to the extensive work undertaken in other east coast canyons. However, these canyons are narrower than the Gully and, as such, they do not affect the general circulation as much. It was noted that we do not have enough knowledge about the physical oceanography to contribute to our understanding of benthic/pelagic coupling.

Dr. Petrie noted that the Gully affects the mean circulation but these effects are based on the output from integrating a model with some very sparse data. However, the size of the Gully is such that it affects the physics unlike most other canyons on the shelf break.

Information Gaps:

- There has not been a systematic array of current meter moorings in the Gully. Consequently, circulation models of the Gully are based on relatively few observational data and are therefore subject to relatively large uncertainties; oceanographic data are lacking, in particular, for the deeper areas of the Gully.

Chemical Oceanography

Presentation and Discussion - Dr. Brian Petrie

Dr. Brian Petrie summarized the contaminant and nutrient data for the Gully. There are data for contaminants in water from the Gully area itself, however, contaminant levels from waters in adjacent areas of the Shelf are low. The potential function of the Gully as a trap for resuspended particles from the Sable Bank, as noted in Mr. Fader's presentation, however, suggests that analysis of fine grain sediments in the deeper part of the Gully would be of interest.

It was questioned whether there is any measurable impact from the outflow from the Gulf of St. Lawrence on the level of contaminants on the Shelf. Dr. Yeats noted that there have been no water samples analysed for contaminants but analyses of sediment and biota from the Shelf do not indicate a problem. Analysis of seal tissue suggest that long range atmospheric transport may be a significant vector for contaminants into the Sable Island area.

Average nutrient concentrations and seasonal patterns are similar in the Gully, Sable, Middle, and Banquereau banks. The one exception is that silicate concentrations are higher on Middle Bank in the spring due to the influence of the St. Lawrence River outflow. There is not enough information to determine if there are horizontal gradients of nutrient concentrations in the Gully. Similarly there is no information available to contribute to an understanding of pelagic/benthic coupling processes in the deeper parts of the Gully. The major source of nutrients in the Gully is probably the slope water. It should be possible to make estimates of the strength of various sources based on the model and the nutrient data-set.

It was questioned whether or not average nutrient concentrations were relevant to predicting productivity and that perhaps measurements of nutrient flux are needed. Dr.

Harrison noted that where we see enhanced productivity on the Shelf, e.g., Georges Bank, we also see an elevation of nutrients.

Information Gaps:

- Data on chemical contaminants (in water, sediments and organisms) in the Gully region are lacking.
- Knowledge of high frequency mixing processes occurring on small spatial scales and their importance for nutrient flux and productivity in the Gully is lacking.

Phytoplankton

Presentation and Discussion - Dr. Glen Harrison

Dr. Glen Harrison summarized the distribution and seasonal cycles of phytoplankton in the Gully based on data from:

1. surface chlorophyll determinations from the Scotian Shelf Icthyoplankton Program (SSIP), 1978-1982;
2. surface chlorophyll maps from colour satellite images from 1978-1986; and
3. depth profiles of chlorophyll from various missions from the USA and BIO.

The fundamental limitation of satellite data is that it only sees the surface (however, highly productive areas like the upwelling off Yarmouth reach the surface waters). There is some evidence (Fig. 6.3.2 in Harrison and Fenton, 1998) for moderately high phytoplankton biomass in the Gully but there are other areas on the shelf that have equal or greater biomass.

Rapporteur's Report and Discussion - Dr. Gareth Harding

There is nothing notable or exceptional about the estimates of standing stock of phytoplankton. However, it was noted that the chlorophyll data from the SSIP has only 3 stations in the Gully area and the timing of the sampling misses the period of the spring bloom. Also, instead of looking at phytoplankton biomass in the Gully we should take a wider view and compare the Gully with other areas of high production. Based on the predicted mean circulation, we should also consider looking to the northwest for increases in productivity and perhaps southwest along the edge of the slope.

Information Gaps:

- Existing data are neither spatially nor temporally resolved sufficiently to assess the importance of some of the mesoscale (i.e. spring and fall "blooms") and small scale processes that determine the region's plankton distribution and productivity.

Zooplankton

Presentation and Discussion - Dr. Glen Harrison

Dr. Harrison summarized the annual cycles of zooplankton biomass and abundance on the Scotian Shelf and in the Gully Region based on data from:

1. the SSIP surveys,
2. Hudson missions in 1995, 1996, and 1997,
3. BIONESS data from 1989, and
4. acoustic backscatter data from 1984 and 1997.

There is no evidence that the Gully has enhanced levels of mesozooplankton but, like other regions of the Shelf, it harbours high concentrations of over-wintering populations of *C. finmarchicus* and krill. However, the Gully may not be the right place to look for increased zooplankton biomass related to any increased primary production in the Gully. The primary production may be transported to the NW as predicted in the model and that is where one might expect to find the increased zooplankton biomass.

It was noted that considerable caution should be used in the interpretation of the SSIP data. It was also noted that the euphaisids that over-winter in the area migrate to deeper water in August and return to the surface in April. Also there is a major change in the zooplankton community in the summer when a group of small copepod species dominates as opposed to the larger *Calanus species* in the winter.

Rapporteur's Report and Discussion - Dr. Gareth Harding

It was noted that the data are very scattered and a lot of inference is being used. There appears to be no difference between the numbers of zooplankton inside and outside the Gully area. However, it was suggested that to assess zooplankton biomass in the Gully area that the two nearest SSIP lines should be used. Thus data from 10 stations would be used rather than from 3. It was also noted that the fish egg and larvae data should be included in this chapter rather than in the Fish and Fisheries chapter.

Information Gaps:

- The links between locally produced plankton and the benthos, fish and mammals of the Gully has not been established.
- Contemporary data, particularly on ichthyoplankton distribution, is lacking.

Seabirds

Presentation and Discussion - Larry Hildebrand

Mr. Larry Hildebrand summarized the information on seabirds as written by Dr. Tony Lock. He emphasized that the community of marine birds on the Scotian Shelf contains

very few species and that at all times of year, there are high numbers of Arctic and Southern hemisphere breeders. The pattern of distribution of the summer and winter avian communities is similar even though totally different species are involved. Data on pelagic seabird distributions are derived from the PIROP database maintained by CWS, which stores counts of seabirds made from ships over a 25 year period. Unfortunately, the PIROP data are over a decade old, are limited in scope, and changes in the methods of data gathering make them less than ideal for deciding whether the Gully is special for seabirds. The data are not comprehensive and only a few PIROP observations have been made near the Gully. These data do not show any unusual concentration of seabird numbers in the area.

Mr. Hildebrand noted that Dr. Whitehead had brought to his attention a number of possible deficiencies in the data and interpretation (see Appendix 3). Dr. Lock was not present at the meeting to rebut this criticism. It will have to be addressed in the final draft of the Review.

It was suggested that seabirds are usually more abundant where there are concentrations of marine mammals. This comment was not discussed. It was noted that the data should be presented for individual species not aggregate numbers. It was also questioned if we knew what these birds were feeding on or responding to but there was little discussion and no answer.

Rapporteur's Report and Discussion

There was no rapporteur for this chapter however it was agreed that as noted during the presentation that the analysis of the seabird data was incomplete.

Information Gaps:

- There is a general lack of information on seabird distributions: (1) in the Gully region and (2) contemporaneous observations along the adjacent shelf edge.
- Information on the functional links between plankton, fish, seabirds and marine mammal distributions/aggregations in the Gully is lacking.

The Benthos

Presentation and Discussion - Dr. Don Gordon

Dr. Don Gordon noted that there is information available in addition to that presented in Chapter 6.4 of the review. This includes information from sampling on Banquereau and Sable Island banks. It was also noted that a description of typical "canyon" habitat benthos is also essential.

Dr. Gordon presented a short (~20 min.) video taken in the Gully in the fall of 1997 at depths up to 500 m. It was noted that the video did not reveal anything that was

unexpected. The "redfish" behavior ((lying on their side with the tail curved toward the bottom) has also been noted with other fish during surveys by submersible.

It was noted that in the Gully, the Hell's Kitchen area is fished with longline for halibut.

Dr. Gordon concluded that there is very limited information available about the benthos of the Gully. There is a lot of room for collaboration on new studies with industry. A comprehensive survey of the Gully benthos could be achieved through the use of new technology such as BRUTIV and Campod and, where needed, quantitative sampling with the video grab, after first undertaking a geological survey.

Rapporteur's Report and Discussion - Dr. Gareth Harding

Very little is known specifically about the benthos in the Gully. The information from the videos taken during Don Gordon's Parizeau research cruise is the only information that we have specifically for the Gully. In general we do not have any information about the benthos for depths greater than 500 m. The video from Gordon's Parizeau research cruise should be analyzed. A description of the Gully benthos should be provided based on the video and a comparison with analogous habitat. It would also be worthwhile to analyse Carl Amos' submersible data for information on benthos in deeper water.

Information Gaps:

- Quantitative information (distribution, community composition and structure, biology and ecology) is lacking on all components of the benthic community in the Gully and adjacent shelf and slope regions.
- Information on the fate of pelagic production and its role in supporting the Gully's benthic communities, i.e. benthic/pelagic coupling, is lacking.
- Information necessary to establish the relationship between bathymetry/surficial geology and benthic community structure and biodiversity is lacking.

Corals

Presentation and Discussion - Dr. Derek Davis

Dr. Derek Davis summarized the information on the types and distribution of corals on the Scotian Shelf. He emphasized that nothing is known about the life history of these corals. He also noted that his data may be skewed by having been obtained from interviews of fishermen; i.e. it is as much a map of fishing activity as it is of coral distribution. It was commented that he might be too conservative and that the distribution in his maps may only be skewed by depth because there is no trawling activity in the deeper waters. Coral distribution is probably much wider than shown in the distribution map (Fig. 6.4.2.1 in Harrision and Fenton, 1998).

In response to a question about preferred substrate type for corals it was noted that initially they need something solid to attach to but as they grow they can establish hold-fasts in soft sediment.

Rapporteur's Report and Discussion - Dr. Gareth Harding

It was noted that based on the Figure 6.4.2.1 concentrations of corals seem to be greater on the west side of the canyons. It was cautioned again that this information comes largely from anecdotal information and should not be analyzed too deeply.

Invertebrate Fisheries

Presentation and Discussion - Dr. John Tremblay

Dr. John Tremblay summarized Chapter 7.2 of the Review. At present squid is the only active commercial fishery for invertebrates in the Gully but nearby there are several active invertebrate fisheries, e.g. clams, scallops, snow crab, and shrimp. Squid is primarily a by-catch of the silver hake fishery; there is no evidence of its abundance in the Gully proper. There is a potential for expanding some fisheries, e.g. snow crab and shrimp, into the Gully and also for new fisheries such as stone crab. The snow crab survey on Scotian Shelf shows a distribution which is expanding southward possibly due to reduction in the bottom water temperature. There is likely to be a concentration in the Gully that is commercially exploitable. It was noted that information on invertebrates in this area is limited because there is no systematic sampling in the Gully and surrounding areas. Any recruitment links between the Gully and the rest of the Scotian Shelf are unknown.

Rapporteur's Report and Discussion - Dr. Gareth Harding

It was observed that the invertebrate data sets are mostly from the shallow areas and that there is no information about the deeper areas of the Gully. The last 10 years of data from the groundfish surveys have not been evaluated; the environment has changed in that time and this may be reflected in the invertebrate distributions. It was noted that it would be useful to check the observer data for dominant invertebrate species and consideration should be given in the future to enumerating all species that come aboard on the groundfish surveys.

Information Gaps:

- Complete distributional data on red crab, stone crab, lobster, other crustaceans are lacking; a possible source of information is the groundfish survey database, but invertebrate species records are not complete.
- Information on the extent of movement of the Gully and the rest of the Scotian Shelf (most finfish and invertebrate species) is lacking.
- Information on the recruitment links of the Gully and the rest of the Scotian Shelf (most finfish and invertebrate species) is lacking.

- Information on interactions with other species is lacking.

Finfish and Selected Invertebrates

Presentation and Discussion - Dr. Kees Zwanenburg

Mr. Zwanenburg summarized Chapter 7.1 of the review. Although at present the fisheries on the Eastern Scotian Shelf are severely restricted relative to the recent past, the Gully continues to be an actively fished area. Longline effort directed at Atlantic halibut and white hake is presently the most common. In the past there has also been significant trawler effort in both the Gully and the adjacent slope waters.

We conclude that the Gully and adjacent waters is an area of relatively high demersal finfish diversity relative to the eastern Scotian Shelf as a whole. There is no evidence for any endemic demersal species of fish, however, given the low sampling rate and the potentially low efficiency of the trawl in areas of rapid changes in bathymetry such as occur in the area, this does not rule out the possibility that such species occur.

The slope waters of the Gully, as is the case for the Scotian Slope in general, is an area of faunal boundaries. The upper reaches of the slope (less than 360 m) represent the lower boundaries of distribution for the shelf dwelling species and the upper limits for those species which are truly slope dwellers. The slope itself, down to depths of about 900 m, has its own ichthyofauna. Beyond these depths the demersal fish fauna changes again to represent that of the lower slope and abyssal rise.

It is unlikely that the species composition of the shelf slope in the Gully is unique. The Gully represent only a small portion of the slope of the Scotian Shelf and it is likely that this composition is indistinguishable from the species composition in adjacent areas of the slope.

The Gully slope is bathed primarily by Labrador Slope water whereas further west warm slope water from the Gulf Stream is a more common occurrence. Many of the >200 species of mesopelagic fishes are southern in distribution, with quite a large number being expatriates from tropical waters. The mesopelagic ichthyofauna of the Labrador Slope water is composed mainly of Sub-arctic-Temperate species. Given this, only a small fraction of the 200 species of mesopelagic fishes is of common occurrence off the Gully, and none are endemic.

The unique bathymetric features of the Gully (rapid changes in bathymetry analogous to terrestrial cliff walls hundreds of meters high) may attract certain of the species observed. Redfish appear to prefer areas of rapid changes in bathymetry at depths >360 m and are therefore relatively abundant in the Gully relative to adjacent areas. Halibut (*Hippoglossus hippoglossus*) also appear to be relatively abundant in the Gully relative to adjacent areas. There are active fisheries for both these species in the area.

The area does not appear to be important for shelf dwelling pelagic species although these do occur there as migrants.

The Gully is an area of high density for redfish, squid, cod, witch flounder, white hake, and longfin hake, relative to the remainder of the eastern Scotian Shelf.

The top nine species of demersal fish occurring in the Gully can be split into those whose dynamics are relatively similar to that demonstrated by that species elsewhere on the eastern Scotian Shelf (redfish, squid and witch flounder) and those whose dynamics show different patterns in the Gully relative to the eastern shelf (American plaice, haddock, cod, silver hake, white hake and pollock). The underlying causes of the different dynamic in these areas has not been investigated.

An analysis of survey data collected for the entire east coast of North America over the period 1970 - 1994 indicate clear faunal boundaries at, among others, the Laurentian Channel, and off Cape Cod. These analyses give no indication of there being a faunal boundary associated with the Gully. An increase in the number of observation associated with the Gully (<200 trawl sets over since 1970) would allow for a more spatial resolution and a more satisfactory analyses of the Gully relative to the adjacent areas.

The Parks Canada report on the Gully and the SOEP Environmental Impact Statement identified the Gully as a significant spawning area. The information presented supports its importance only as a potentially important spawning area for silver hake, although the density of silver hake spawning products in the Gully was not compared to those outside the Gully. The Gully was not found to be an important area for adult silver hake. It was noted that the adults were not present at the time of the surveys but may be present at other times of the year.

The presentation stressed that these analyses represent only a first level of the description which could be derived from additional analyses.

Rapporteur's Report and Discussion - Norvil Collins

In general the Gully does not appear to be important habitat for commercial species however the knowledge base is lacking for non-commercial stocks. The importance of the Gully for retaining production versus exporting production to the northwest was discussed again (see Section 3.4.2). For example, until the moratorium on the ground fishery, there was a persistent fall pollock fishery to the north of the Gully.

There was a number of suggestions made regarding different analyses and approaches to the analyses of this set of data, including:

- Exploring the SSIP data to determine the relevance of numbers in the Gully with respect to the rest of the eastern Scotian Shelf.
- The analysis for finfish diversity only compared numbers. Other analyses, such as age or size, might reveal the importance of the Gully for specific age groups.

- It would be instructive to analyze the information on the Gully fauna for various predator/prey relationships.
- The observer data are on a finer scale than the data used and it is would be useful to analyse that data.

There was a discussion of the apparent inconsistency between the swordfish data and comment in Appendix 12.2 about the impact of closure on the fishery. It was concluded that this type of comment was outside of the mandate of the review and that the statement should be removed from the document.

Information Gaps:

- Information on the seasonal distribution of finfish in lacking, particularly outside the summer survey periods.
- Information on the extent of movement between the Gully and the rest of the Scotian Shelf (most finfish and invertebrate species) is lacking.
- Information on the recruitment links between the Gully and the rest of the Scotian Shelf (most finfish and invertebrate species) is lacking.
- Information on interactions with other species is lacking.

Marine Mammals

Presentation and Discussion - Dr. Hal Whitehead

Dr. Whitehead presented a summary of Chapter 9 of the Review. It was noted that based on observations of the stomach contents of bottlenose whales stranded on the coast of Nova Scotia, it is believed that they feed on the squid *Gonatus fabricii*. These whales are regularly diving in the Gully to depths of approximately 1400 m, the deepest modal dives of any whale species.

There was a consensus that of the 8 cetacean species that are frequently sighted in the Gully, it is an important habitat for the bottlenose whale and for some of the sperm whales. Baleen whales sighted in the Gully may be just passing through the area. Their movement through the area is not analogous to the shorebird migration through the Bay of Fundy. The shorebirds have a destination while the whales supposedly stop at the Gully because there is food available.

Dr. Whitehead noted that since there were no standard techniques for recording whale sighting data, they had only used their own data in order to minimize the problems created by different techniques. It was argued that the present data was very limited and therefore inclusion of the observer data, with its wider geographic coverage, would help with the interpretation. It was also suggested that other approaches to interpreting the data could be used to minimize the impact from different observation techniques. While it was suggested that it would be useful to compare sightings in the Gully with sightings along a comparable area of the Scotian Shelf slope, Dr. Whitehead noted that due to the limited data this was not possible.

It was suggested that the Gully might be an important feeding area for pinnipeds. However, recent studies by Don Bowen indicate that this does not appear to be the case. The critical area for the seals, grey and harbour, is Sable Island and its environs. It was noted that the Harbour seal has essentially disappeared from Sable Island this year probably as a result of predation by sharks and competition with the grey seal.

This chapter on marine mammals tackled the issue of what the boundary for the Gully should be. The question was raised as to why the other authors had not tackled this issue. In some cases there was no rationale based on the information available to select a boundary. In other cases the reviewers focused on the data collection and interpretation.

Rapporteur's Report and Discussion - Dr. Trevor Kenchington

There was considerable discussion about the comparison of whale sightings in the Gully versus other parts of the Scotian Shelf and whether or not the numbers seen in the Gully are, to some degree, a result of it being along a major migration route for whales. It was agreed that this might be the case for some species but not for the bottlenose and blue whales.

The analysis of the data from the Blandford whaling station was questioned but it was agreed that it was a useful analysis provided undue emphasis is not placed on its interpretation. It was asked why catch per-unit effort (CPUE) data were not used for the Blandford data and it was pointed out that CPUE is not a useful statistic for whaling.

It was recommended that other data sets, such as the observer data, should be included in the report for information even though it is not possible to evaluate them statistically.

The consensus was that there is no evidence to support the Gully being a major forage area for the grey seal.

It was noted that the acoustic environment of the Gully could be a critical factor for marine mammals.

Information Gaps:

- Data on at-sea distribution of pinnipeds are lacking.
- Data on cetacean distribution in the Gully outside the summer months are lacking.
- Information on how cetaceans use the Gully area is lacking.
- Data on the acoustic ambient noise of the Gully and its influence on the behavior of local marine mammal populations are lacking.

GENERAL DISCUSSION

As noted earlier in the Background section, there was concern about the remit for this RAP meeting and the contents of the HSR. The consensus was that the purpose the HSR

was to report on the status of the Gully ecosystem, not solely to document unique or special features. Any research recommendations would be recorded in these proceedings.

It was also recommended that a chapter be included that synthesized and integrated the various chapters into an overview of the Gully ecosystem. This chapter should be fairly general and brief and can draw heavily on existing papers such as Shackell et al. (1996). It should also deal with flows into and out of the Gully and trophic energy flows and relationships. It needs to be written in a "readable" and "story-like" manner with illustrations, similar to Museum documents. The chapters on Ecosystem Classification by Inka Milewski and Derek Davis should be included even though they were not presented at the RAP. They provide a useful overview to this subject.

RECOMMENDATIONS:

There were a number of general recommendations that resulted from the discussions.

1. Despite the substantial amount of data the Science Review team has compiled, there are still key components of the Gully ecosystem on which we have virtually no quantitative information and other key components upon which we have incomplete information. As a consequence **an integrated ecosystem description of the Gully is not possible now, however, the same could be said for our understanding of the environment and ecosystems of Scotian Shelf in general.**

2. In the case of the benthos of the Gully, virtually nothing is known about community structure and distribution. Data have been collected on the occurrence of deep sea corals but nothing is known quantitatively about their ecology or biology. Additionally, some information on the occurrence of commercial benthic invertebrates exists but their distribution in the Gully, movements between the Gully and the rest of the Shelf, recruitment and interactions with other species is unknown. This lack of information on a fundamental component of the Gully ecosystem requires that **further research is needed to establish a baseline of information on the distribution and structure of the benthic communities of the Gully.**

3. The concern has also been expressed that much of the existing data are old (collected decades ago) and may not reflect the contemporary situation (e.g. ichthyoplankton, and seabird distributions). Have there been significant changes in these components in the intervening time? Other data sets are reasonably up to date although often sparse and scattered (e.g. geology, physical and chemical oceanography, finfish, mammals). Thus **surveys are required to collect current information on variables that are susceptible to change with time**.

4. Another recurring concern is that the spatial and temporal resolution of the available data are inadequate to address unambiguously questions relating to: (1) the uniqueness of the Gully as compared to the rest of the Scotian Shelf, (2) the processes occurring within the Gully that influence productivity of the region and (3) the issue of defining operational "boundaries" for the Gully. Notably, descriptions of the

physical, chemical and biological oceanography from limited small-scale studies showed that oceanographic conditions conducive to enhanced nutrient supply and productivity might exist in the Gully but were not discernible from conventional coarse-scale sampling. A similar argument was made in evaluating the distribution of pelagic seabirds in the vicinity of the Gully. Clearly, data with a spatial density considerably greater than the 10s of km that define the bathymetric "boundaries" of the Gully (e.g. the 200m contour) and temporal resolution shorter than seasonal or monthly means would be required to address the dynamics that characterize the Gully on the small scale. At present, the only data with adequate spatial resolution are from the multibeam seismic instrumentation for geological and hydrographical studies, acoustics and towed instrumentation (including video) for oceanography and fish, and airborne surveillance for seabirds and mammals. These data are limited to small areas of the Gully or are simply unavailable, however. It is evident, therefore, that **the more widespread use of technology that permits rapid, high spatial resolution sampling will be required to adequately address questions relating to the characteristics of the Gully with regard to its ecologically dynamic features and will be required to delineate Gully boundaries based on biological as well as physical properties.**

5. Filling information gaps will be a necessary but not sufficient condition to develop an integrated ecosystem description of the Gully. Fundamental questions remain about the functional linkages between ocean physics-chemistry and productivity of the plankton, the benthos (i.e. benthic-pelagic coupling) and the aggregation of seabirds and marine mammals in the region. No single research organization, including DFO, has the capabilities to carry out a complete system study. It is essential, therefore, **that the various government and NGO researchers and stakeholders should commit resources for more focused, coordinated and comprehensive research in the Gully region in order to develop a better understanding of the processes which account for its abundant and diverse biota.** Scientific information collection will also benefit from and should be supplemented by the working knowledge of resource users, i.e. traditional ecological knowledge.

6. The Science Review team acknowledged that information gaps will exist even if all recommendations are implemented. Therefore **in cases where crucial scientific information is lacking, the "precautionary approach" as stated in the Oceans Act must be applied.**

7. The Gully Science Review team was given the task of assembling information on a geographically small area of the Scotian Shelf but without being given strict guidelines on the nature and scope of the review. This can be described as a "bottom-up" approach for developing an understanding of a region's environment and ecology. The Gully Science Review has taken almost a year to complete and has involved the commitment of considerable time from numerous experts from within and outside the government. Two reports at the end of the Science Review propose that a "top-down" approach based on a systems classification scheme may be a more logical and efficient approach. The science of system planning is, in fact, a mature one,

developed decades ago and successfully applied as a tool for classifying terrestrial ecosystems. It is currently being adapted to marine ecosystems. It is the belief of the Gully Science Review team in judging the merits of "bottom-up" versus "top-down" approaches that consideration of the time and resources that went into the Gully Science Review, the prospect for others in the future, and considering that much of the ground work has already been laid in systems classification of the Scotian Shelf **a systems planning approach to ecosystem classification should be implemented by DFO as a framework for meeting future departmental requirements for science information for our regional waters.**

Systems planning is not considered a substitute for the site-based, focused research required to address region-specific questions but will provide the background information necessary for more efficient use of research personnel and resources and for placing the scientific understanding gained in the broader system context.

REFERENCES

Evans, P.G.H. 1982. Cetacean-Seabird Associations: A Review. Mammal Review 10: 1-52.

Sandstrom, H., and J. Elliott. 1984. Internal Tide and Solitons on the Scotian Shelf: A Nutrient Pump at Work. J. Geophys. Res. 89: 6415-6426.

Shackell, N., P. Simard, and M. Butler. 1996. Potential Protected Area in the Gully Region, Scotian Shelf. Report to World Wildlife Fund of Canada. June, 1996.

Weatherbee, R.A. 1997. The Distribution and Abundance of Pelagic Birds in 'The Gully'. B.Sc. Thesis, Dalhousie University: 59pp.

APPENDIX 1. List of attendees at the RAP Habitat Subcommittee meeting - February 10 -11, 1998.

Name	Organization
Frank Almeida	Woods Whole Oceanographic Institute
Peter Auster	University of Connecticut
Cynthia Boubonnais	DFO, Marine Environmental Sciences Division
Steven Brown	National Atmospheric and Oceanic Administration
Andy Cameron	Nova Scotia Department of Fisheries and Aquaculture
Norvil Collins	CEF Consultants
Derek Davis	Nova Scotia Museum
Claude d'Entremont	InShore Fisheries Ltd.
Gordon Fader	NRCan, Geological Survey of Canada, Atlantic
Derek Fenton	DFO, Oceans Act Coordination Office
Brian Giroux	Scotia-Fundy Mobile Gear Fishermen's Association
Don Gordon	DFO, Marine Environmental Sciences Division
Gareth Harding	DFO, Marine Environmental Sciences Division
Glen Harrison	DFO, Ocean Sciences Division
Larry Hildebrand	Environment Canada
Paul Keizer	DFO, Marine Environmental Sciences Division
Trevor Kenchington	Gadus Associates
Kevin MacIsaac	DFO, Marine Environmental Sciences Division
Inka Milewski	World Wildlife Fund
Brian Petrie	DFO, Ocean Sciences Division
Gary Rockwell	DFO, Canadian Hydrographic Service
Bob Rutherford	DFO, Oceans Act Coordination Office
Faith Scattolon	DFO, Oceans Act Coordination Office
Nancy Shackell	Ecology Action Centre
Sandra Farwell	Seafood Producers Association of Nova Scotia
John Tremblay	DFO, Invertebrate Fisheries Division
Phil Tsui	Mobil Oil
Evan Walters	Scotia-Fundy Inshore Fisherman's Association
Hal Whitehead	Dalhousie University
Maritn Willison	Dalhousie University
Phil Yeats	DFO, Marine Environmental Sciences Division
Kees Zwanenburg	DFO, Marine Fisheries Division
Bob O'Boyle	DFO, RAP Office
Shannon Gowans	Dalhousie University
Sasha Hooker	Dalhousie University

APPENDIX 2: Agenda of the RAP Habitat Subcommittee meeting - February 10-11, 1998

Agenda
RAP Habitat Subcommittee Meeting
Class of '47 Boardroom, 19th Floor, Maritime Centre, Halifax
10 - 11 February 1998

	10 February Tuesday	**11 February Wednesday**
0830-0900	Introduction Paul Keizer, Habitat Committee Chair	Rapporteur's Report & Discussion Geoscience (Derek Fenton)
0900-0930	Presentation of HSR - Glen Harrison (DFO), Review Team Leader	Rapporteur's Report & Discussion Physical & Chemical Oceanography (Phil Yeats)
0930-1000	Geoscience Gordon Fader (NRCan)	Rapporteur's Report & Discussion Plankton (Gareth Harding)
1000-1030	Physical & Chemical Oceanography Brian Petrie (DFO)	Rapporteur's Report & Discussion Benthos (Gareth Harding)
1030-1045	Break	Break
1045-1115	Plankton Glen Harrison	Rapporteur's Report & Discussion Invertebrates (Gareth Harding)
1115-1145	Seabirds Larry Hildebrand (EC)	
1200-1245	**Lunch** (not supplied - Food Court)	**Lunch** (not supplied - Food Court)
1245-1330	The Benthos (video) Don Gordon	Rapporteur's Report & Discussion Finfish (Norvil Collins)
1330-1400	The Benthos (Corals) Derek Davis	
1400-1445	Invertebrates John Tremblay	Rapporteur's Report & Discussion Marine Mammals (Trevor Kenchington)
1445-1500	Break	Break
1500-1600	Finfish Kees Zwanenburg (DFO)	HSR Review
1600-1700	Marine Mammals Hal Whitehead (Dalhousie Univ.)	HSR Review

APPENDIX 3: Notes on seabird sightings from H. Whitehead

Seabirds sighted per standard 10-min PIROP watch inside and outside the Gully (but on the Scotian Shelf) during June-August (from Weatherbee 1997)

Species	In Gully	Outside Gully	Ratio: Inside/Outside (assuming speed)
Watches	134	280	
Assumed speed	5. kn	10 kn	
Fulmar	1.48/watch	0.62/watch	4.4
Sooty Shearwater	0.60	0.41	2.6
Greater Shearwater	11.54	7.75	2.6
Storm petrel	5.48	3.05	3.4
Herring gull	0.70	1.41	1.0
Greater black-back gull	0.87	1.44	1.0

Possible biases:

Observer experience: diminish significance of Gully
Sighting platform: diminish significance of Gully
Trends in abundance (~1992-1996):
Increasing species (e.g. fulmar): inflate Significance of Gully
Declining species (e.g. sooty shearwater): diminsh significance of Gully

Lock:

"*Weatherbee noted that .. when compared to the rest of the Scotian Shelf some species appeared less abundant, and others: Greater shearwaters and petrels for instance,... slightly more abundant.*"

Chemistry, phytoplankton, zooplankton, tuna and swordfish are not special in the Gully, so Lock concludes:

"*A reasonable conclusion, based on the data available, is that seabird numbers and species composition around the Gully are comparable to those observed elsewhere on the shelf edge.*"

However, the same document shows that marine mammals have increased abundance in the Gully, and the distributions of many seabirds are known to be well correlated with those of cetaceans (Evans 1982).

Species frequently sighted in the Gully, not mentioned by Lock:

Cory's shearwater, manx shearwater, skua jaeger (2-3 species), tern (2 species)

APPENDIX 4: Notes for presentation on invertebrates by John Tremblay

1. Invertebrate sources

- Data sources
- Species fished now
- Potential commercial species
  - Developed
  - Developing
- Summary

2. Invertebrate Fisheries in the Gully Region

- Data sources
- Technical reports
- No single database for benthic inverts
- Groundfish surveys: some distribution data

3. Major Invertebrate species

- Scallops
- Surfclam
- Snow Crab
- Shrimp
- Squid

4. Scallops

- Sable Island, Western, Middle & Banquereau Banks
- depths < 125 m
- up to ~ 4000 mt (round)

5. Surfclams and others

- Surfclam is targeted species
- Banquereau Bank
- depths < 100 m
- Propeller clams and Ocean quahogs a bycatch

6. Snow Crab

- Snow crab fished in deep areas (generally > 120 m)
- bottom temperatures < 3 °C
- some fishing in the Gully

7. Shrimp

- distribution similar to snow crab
- deep, on mud bottoms
- fishable concentrations likely in the Gully

8. Squid (Illex illecebrosus)

- can be highly abundant on the Scotian Shelf
- Squid prefer warmer waters (> 6 °C) and are distributed on the outer shelf and slope
- in Emerald and La Have Basins and in the Gully.

9. Species fished elsewhere on the Shelf

- Lobster
- Red Crab

10. Developing or potential fisheries

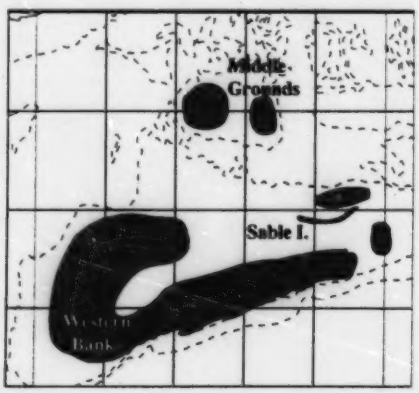
- Stone Crab (*Lithodes maja*)
  - some potential in the Gully
  - reliable comparative data lacking
- Others
  - deep-water shrimp
  - distribution data lacking

11. Invertebrate Fisheries in the Gully Region

- Summary
- commercially important species in and around the Gully
- information mainly "broad brush"
- Gully uniqueness cannot be evaluated

Scallop fishing areas on the eastern Scotian Shelf adjacent to the Gully

Figure from SSR by G. Robert, IFD, DFO



Offshore lobster fishing effort

Fig. from SSR by D. Pezzack, IFD, DFO

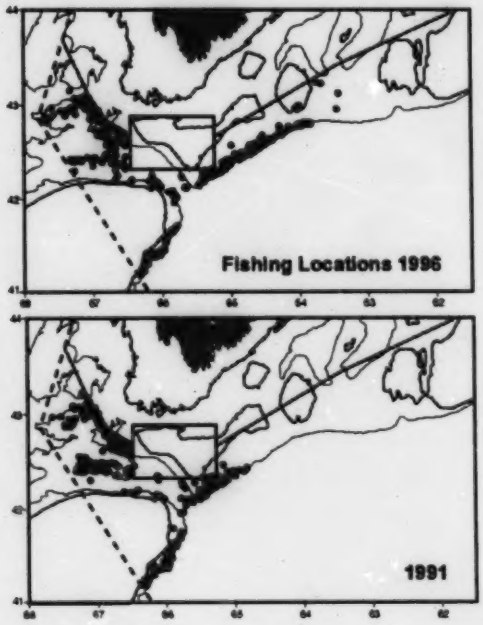
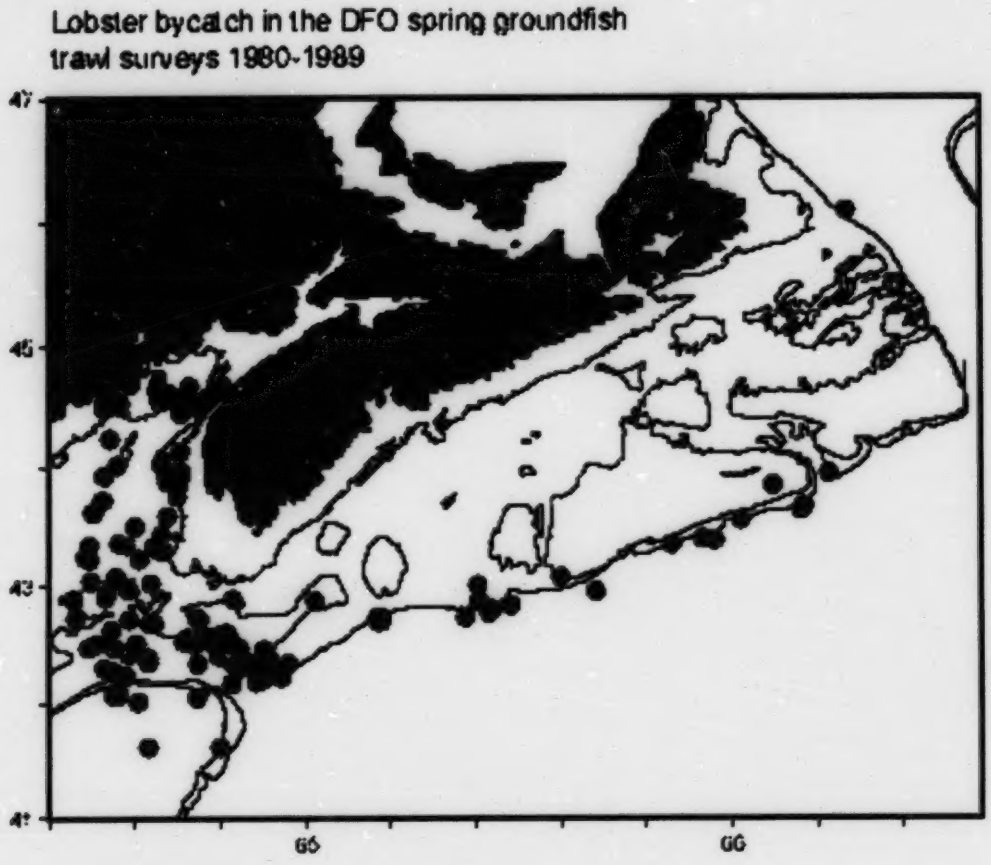
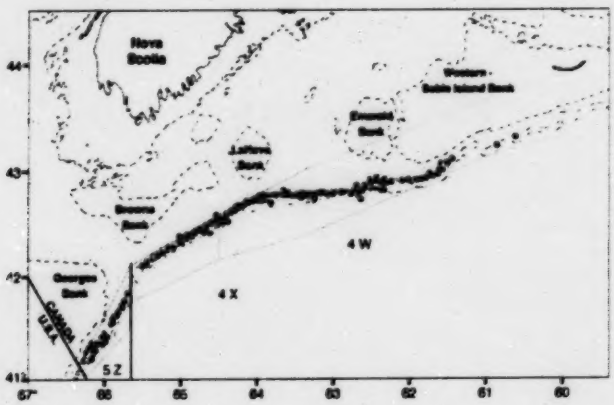


Figure from SSR by D. Pezzack Lobster distribution: trawl survey



Red crab fishing effort
From SSR by P. Lawton & D. Duggan



APPENDIX 5: Additional information on benthos provided by Don Gordon

ADDITIONAL INFORMATION FOR GULLY SCIENCE REVIEW
BENTHIC ECOLOGY
(10 February 1998)

Additional Benthic Samples/Data bases for the Scotian Shelf

Emerald Bank

Parizeau 96-009 (two sites)
- 7 epibenthic sleds
- 10 videograbs
- 20 Campods (video and still photos)
- Samples not processed

Western Bank

Parizeau 92-034 (two sites)
- 12 epibenthic sleds
- 12 videograbs
- Prena et al (1996)

Parizeau 96-009 (two sites)
- 4 BRUTIV video lines
- 11 epibenthic sleds
- 14 videograbs
- 20 Campods (video and still photos)
- Samples partially processed

Parizeau 96-053 (Otter trawling experiment)
- 4 BRUTIV video lines
- 20 videograbs
- 30 Campods (video and still photos)
- Samples processing underway

Sable Island Bank

Collections by DFO before 1991 (Margoliase at DFO Mont Joli)

LASMO supply vessels
- 14 stations (5 replicates each) along two transects out from Cohasset using 0.5 m^2 van Veen grab. May and December 1993.
- (LASMO 1994)

Parizeau 96-009
- 10 epibenthic sleds
- 10 videograbs

10 Campods (video and still photos)
Along transect west of Panuke.
Samples not processed.

6 Campods (video and still photos) at SOEP sites

Banquereau

Parizeau 96-009 (observations at clamming site)
4 BRUTIV video lines
30 videograbs
30 Campods (video and still photos)
Samples processed and preliminary data analysis

Parizeau 97-053 (observations at two potential experimental sites)
4 BRUTIV video lines
12 videograbs
Samples being processed now.

The Gully

Parizeau 97-053
34 Campods (video and still photos)
Imagery partially processed. See demonstration video.

Additional References for Scotian Shelf Benthos

LASMO 1994. Cohasset oil-based drilling mud environmental monitoring program, LASMO Nova Scotia Ltd, 1993 program results. Report prepared by John Parsons and Associates.

Lawrence, P., Strong K.W., Pocklington P., Stewart P. and Fader G. (1989). A photographic atlas of the eastern Canadian continental shelf: Scotian Shelf and Grand Banks of Newfoundland. Geol. Surv. Can. Open File 2054.

Prena, J., T.W. Rowell, P. Schwinghamer, K. Gilkinson and D.C. Gordon Jr. 1996. Grand Banks otter traweling impact experiment: I. Site selection process, with a description of macrofaunal communities. Can. Tech. Rep. Fish. Aquat. Sci. 2094: viii+38p.

EQUIPMENT DEVELOPMENT

Video Grab

- Hydraulically-operated, 0.5 m^2
- Equipped with high resolution colour video camera to view bottom and operation
- Landing and closure controlled in laboratory

Epibenthic Sled

- Modification of Aquareve III to make more quantitative
- Equipped with video camera to view operation

BRUTIV (Benthic Referenced Underwater Towed Instrument Vehicle)

- Improvements to earlier models
- Towed at several knows at set distance off seafloor
- Equipped with video camera to view bottom

DRUMS™ (Dynamically Responding Underwater Matrix Sonar)

- Developed specifically for this project by Guigné International Ltd
- Broad frequency spectrum, narrow beam acoustics
- High resolution measurement of sediment habitat structure
- Mounted on video grab

APPENDIX 6: Summary of information gaps and recommendations from the Regional Advisory Process Meeting on the Gully Science Review; February 10-11, 1998.

This information is extracted from the Canadian Stock Assessment Proceedings Series 98/2, The Proceedings of Meeting 7, February 10 and 11, 1998, Regional Advisory Process (RAP), Habitat Subcommittee: The Gully Science Review.

INFORMATION GAPS

Geosciences & Hydrography

- The geology of the Gully is based on older datasets and consequently less well known than adjacent regions (e.g. Grand Banks) where newer data gathering techniques have been used.
- There is little information on the geology of the deeper (>800m) areas of the Gully; <1% of that area has been surveyed.

Physical & Chemical Oceanography

- There has not been a systematic array of current meter moorings in the Gully. Consequently, circulation models of the Gully are based on relatively few observational data and are therefore subject to relatively large uncertainties; oceanographic data are lacking, in particular, for the deeper areas of the Gully.
- Data on chemical contaminants (in water, sediments and organisms) in the Gully region are lacking.
- Knowledge of high frequency mixing processes occurring on small spatial scales and their importance for nutrient flux and productivity in the Gully is lacking.

Biological Oceanography - Plankton

- Existing data are neither spatially nor temporally resolved sufficiently to assess the importance of some of the mesoscale (i.e. spring and fall "blooms") and small scale processes that determine the region's plankton distribution and productivity.
- The links between locally produced plankton and the benthos, fish and mammals of the Gully has not been established.
- Contemporary data, particularly on ichthyoplankton distribution, is lacking.

Benthos

- Quantitative information (distribution, community composition and structure, biology and ecology) is lacking on all components of the benthic community in the Gully and adjacent shelf and slope regions.
- Information on the fate of pelagic production and its role in supporting the Gully's benthic communities, i.e. benthic/pelagic coupling, is lacking.
- Information necessary to establish the relationship between bathymetry/surficial geology and benthic community structure and biodiversity is lacking.

Fish & Fisheries

- Information on the seasonal distribution of finfish in lacking, particularly outside the summer survey periods.
- Complete distributional data on red crab, stone crab, lobster, other crustaceans are lacking; a possible source of information is the groundfish survey database, but invertebrate species records are not complete.
- Information on the extent of movement between the Gully and the rest of the Scotian Shelf (most finfish and invertebrate species) is lacking.
- Information on the recruitment links between the Gully and the rest of the Scotian Shelf (most finfish and invertebrate species) is lacking.
- Information on interactions with other species is lacking.

Seabirds

- There is a general lack of information on seabird distributions: (1) in the Gully region and (2) contemporaneous observations along the adjacent shelf edge.
- Information on the functional links between plankton, fish, seabirds and marine mammal distributions/aggregations in the Gully is lacking.

Marine Mammals

- Data on at-sea distribution of pinnipeds are lacking.
- Data on cetacean distribution in the Gully outside the summer months are lacking.
- Information on how cetaceans use the Gully area is lacking.
- Data on the acoustic ambient noise of the Gully and its influence on the behavior of local marine mammal populations are lacking.

RECOMMENDATIONS:

There were a number of general recommendations that resulted from the discussions.

1. Despite the substantial amount of data the Science Review team has compiled, there are still key components of the Gully ecosystem that we have virtually no quantitative information on and other key components upon which we have incomplete information. As a consequence **an integrated ecosystem description of the Gully is not possible now, however, the same could be said for our understanding of the environment and ecosystems of Scotian Shelf in general.**

2. In the case of the benthos of the Gully, virtually nothing is known about community structure and distribution. Data have been collected on the occurrence of deep sea corals but nothing is known quantitatively about their ecology or biology. Additionally, some information on the occurrence of commercial benthic invertebrates exists but their distribution in the Gully, movements between the Gully and the rest of the Shelf, recruitment and interactions with other species is unknown. This lack of information on a fundamental component of the Gully ecosystem

requires that **further research is needed to establish a baseline of information on the distribution and structure of the benthic communities of the Gully.**

3. The concern has also been expressed that much of the existing data are old (collected decades ago) and may not reflect the contemporary situation (e.g. ichthyoplankton, and seabird distributions). Have there been significant changes in these components in the intervening time? Other data sets are reasonably up to date although often sparse and scattered (e.g. geology, physical and chemical oceanography, finfish, mammals). Thus **surveys are required to collect current information on variables that are susceptible to change with time.**

4. Another recurring concern is that the spatial and temporal resolution of the available data are inadequate to address unambiguously questions relating to: (1) the uniqueness of the Gully as compared to the rest of the Scotian Shelf, (2) the processes occurring within the Gully that influence productivity of the region and (3) the issue of defining operational "boundaries" for the Gully. Notably, descriptions of the physical, chemical and biological oceanography from limited small-scale studies showed that oceanographic conditions conducive to enhanced nutrient supply and productivity might exist in the Gully but were not discernible from conventional coarse-scale sampling. A similar argument was made in evaluating the distribution of pelagic seabirds in the vicinity of the Gully. Clearly, data with a spatial density considerably greater than the 10s of km that define the bathymetric "boundaries" of the Gully (e.g. the 200m contour) and temporal resolution shorter than seasonal or monthly means would be required to address the dynamics that characterize the Gully on the small scale. At present, the only data with adequate spatial resolution are from the multibeam seismic instrumentation for geological and hydrographical studies, acoustics and towed instrumentation (including video) for oceanography and fish, and airborne surveillance for seabirds and mammals. These data are limited to small areas of the Gully or are simply unavailable, however. It is evident, therefore, that **the more widespread use of technology that permits rapid, high spatial resolution sampling will be required to adequately address questions relating to the characteristics of the Gully with regard to its ecologically dynamic features and will be required to delineate Gully boundaries based on biological as well as physical properties.**

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collection will also benefit from and should be supplemented by the working knowledge of resource users, i.e. traditional ecological knowledge.

6. The Science Review team acknowledged that information gaps will exist even if all recommendations are implemented. Therefore **in cases where crucial scientific information is lacking, the "precautionary approach" as stated in the Oceans Act must be applied.**

7. The Gully Science Review team was given the task of assembling information on a geographically small area of the Scotian Shelf but without being given strict guidelines on the nature and scope of the review. This can be described as a "bottom-up" approach for developing an understanding of a region's environment and ecology. The Gully Science Review has taken almost a year to complete and has involved the commitment of considerable time from numerous experts from within and outside the government. Two reports at the end of the Science Review propose that a "top-down" approach based on a systems classification scheme may be a more logical and efficient approach. The science of system planning is, in fact, a mature one, developed decades ago and successfully applied as a tool for classifying terrestrial ecosystems. It is currently being adapted to marine ecosystems. It is the belief of the Gully Science Review team in judging the merits of "bottom-up" versus "top-down" approaches that consideration of the time and resources that went into the Gully Science Review, the prospect for others in the future, and considering that much of the ground work has already been laid in systems classification of the Scotian Shelf **a systems planning approach to ecosystem classification should be implemented by DFO as a framework for meeting future departmental requirements for science information for our regional waters.**

   Systems planning is not considered a substitute for the site-based, focused research required to address region-specific questions but will provide the background information necessary for more efficient use of research personnel and resources and for placing the scientific understanding gained in the broader system context.

Figure 1: Location of recent benthic sampling on eastern Scotian Shelf (1992-1997)

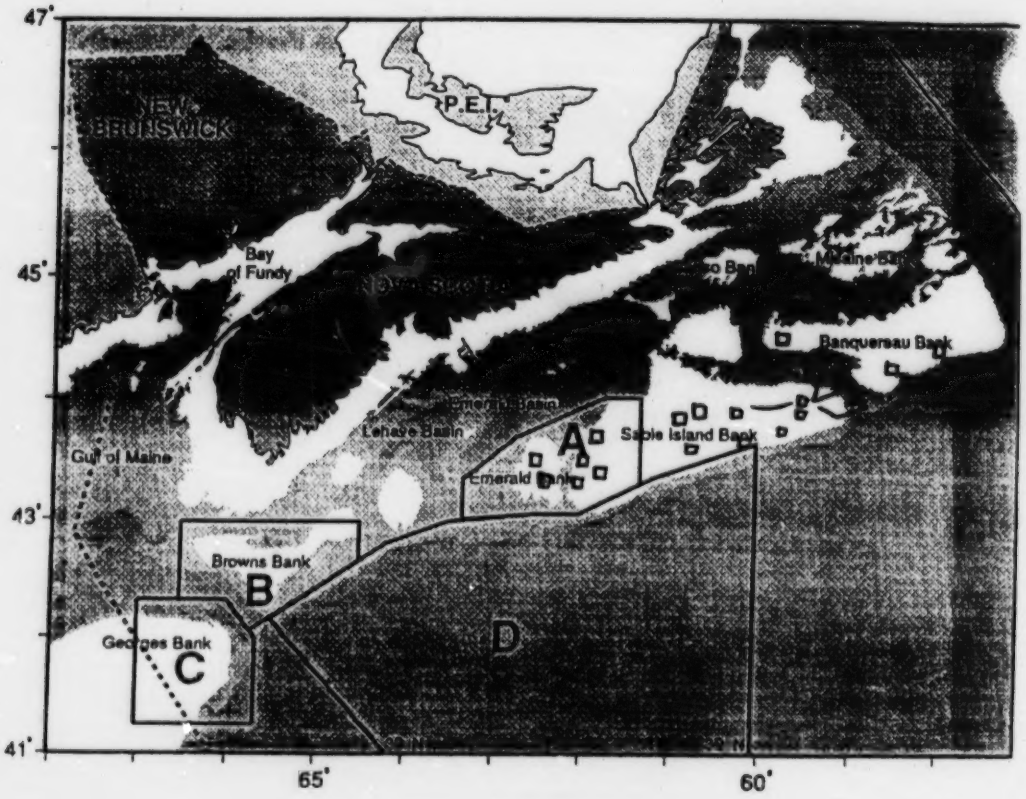

Figure 2: Map of Gully benthic video survey locations, October 1997, CSS Parizeau 97-053